PowerVR PMX-1C

Direct Draw 2D API

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TABLE OF CONTENTS

Introduction 1
1. Pixel Format Definitions 2
1.1 RGB 565 2
1.2 RGB 555 2
1.3 RGB 888 3
1.4 BGR 888 3
1.5 YUV 420 3
1.6 YUV 444 3
1.7 VUY444 3
1.8 Grey Scale 3
1.9 YUYV 3
1.10 YVYU 4
1.11 UYVY 4
1.12 Palettised 12 Bit 4
1.13 Palettised 8 Bit 4
1.14 Palettised 4 Bit 4
1.15 Palettised 2 Bit 5
1.16 Palettised 1 Bit 5
1.17 ARGB 1555 5
1.18 ARGB 4444 5
1.19 ARGB 8888 5
1.20 ABGR 8888 5
2. Background Thread Command Header 6
3. Additional Blit Parameters 6
4. General Blit Setup 7
4.1 Blit Syncronisation 7
4.1.1 Blit Initialisation 7
4.1.2 Blit Completion 7
5. Blit Types 8
5.1 Colour Fill Blit 8
5.2 Same Format Blit 9
5.3 Simple Format Blit 12
5.4 Scaled Blit 15

5.5 Colour Space Conversion Blit 19
5.6 Scaled Colour Space Conversion Blit.....23
5.7 Deplanarise Blit 26

INTRODUCTION

This document describes the 2D Blit types and their data structures used for PMX1C. The Blit types have been designed specifically for DirectX 6 although are all generically structured and so can be used for other purposes with little, if any alterations.

The Blit types described are used by the Direct Draw HAL driver on any calls to handle Blit operations.

Some of the terminologies refereed to within this document are not expanded upon to limit the area covered. It may be necessary to refer to other documents related to this subject to gain further understanding of the principles and techniques used when interfacing PMX1C.

Chapter 1 will describe the *Pixel Format Definitions*, which covers all the pixel formats which Direct Draw understands is supported with reference to PMX1C. Chapter 2 will describe the *Background Thread Command Hander* which is required in all the Blit data structures and what it is. Chapter 3 will describe the *Additional Blit Parameters* which can be passed to most Blit code fragments. Chapter 4 will describe general synchronisation issues which are required when using the Blits and Chapter 5 will describe each of the Blit types in detail.

1. PIXEL FORMAT DEFINITIONS

Each pixel format is encoded within a dword. Fields within this dword describe the characteristics of the pixel format. These pixel format definitions are described here for completeness only and should not be changed in any way as the formats are known to the hardware and any unexpected pixel format will cause an undefined behaviour.

31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode

Unpack Mode

On certain blits the source pixels are unpacked into a generic format (generally required during format conversion and when operations are carried out on the pixel data such as bilinear filtering). This defines the source pixel format.

Magic Number

Unique identifier for each pixel format.

Pack Mode

The Pack Mode defines what pixel format will be output to the destination surface and is required for the same purpose as the **Unpack Mode.**

Zero Alpha

Not all pixel formats have an Alpha channel. During blits which require a pixel format conversion using a source pixel format which does not have an alpha channel and a destination pixel format which does have an Alpha channel this bit (in the source pixel format) indicates that the source Alpha channel should be zeroed (enabling the destination pixel format to have an Alpha channel set to zero).

Pixel Stride

Number of bytes per pixel.

1.1 RGB 565

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	1	2	1	0	2

#define **PMXDD_FORMAT_RGB565** ((2 << 24) | (1 << 21) | (2 << 16) | (1 << 8) | 2)

1.2 RGB 555

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	1	3	2	0	3

#define **PMXDD_FORMAT_RGB555** ((2 << 24) | (1 << 21) | (3 << 16) | (2 << 8) | 3)

1.3 RGB 888

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	3	0	1	4	3	0	4

#define **PMXDD_FORMAT_RGB888** ((3 << 24) | (1 << 21) | (4 << 16) | (3 << 8) | 4)

1.4 BGR 888

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	3	0	1	4+16	4	0	16+4

#define **PMXDD_FORMAT_BGR888** ((3 << 24) | (1 << 21) | ((16 + 4) << 16) | (4 << 8) | (16 + 4))

1.5 YUV 420

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	0	5	0	0

#define **PMXDD_FORMAT_YUV420** ((2 << 24) | (0 << 16) | (5 << 8) | 0)

1.6 YUV 444

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	3	0	0	0	6	0	0

#define **PMXDD_FORMAT_YUV444** ((3 << 24) | (0 << 16) | (6 << 8) | 0)

1.7 VUY444

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	3	0	0	0	7	0	16

#define **PMXDD_FORMAT_VUY444** ((3 << 24) | (0 << 16) | (7 << 8) | 16)

1.8 Grey Scale

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	1	0	0	0	8	0	0

#define **PMXDD_FORMAT_GREY_SCALE** ((1 << 24) | (0 << 16) | (8 << 8) | 0)

1.9 YUYV

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode

31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	0	9	0	14

#define **PMXDD_FORMAT_YUYV** ((2 << 24) | (0 << 16) | (9 << 8) | 14)

Note: Not supported by PMX-1C DAC hardware.

1.10 YVYU

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	0	10	0	14

#define **PMXDD_FORMAT_YVYU** ((2 << 24) | (0 << 16) | (10 << 8) | 14)

1.11 UYVY

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	0	11	0	15

#define **PMXDD_FORMAT_UYVY** ((2 << 24) | (0 << 16) | (11 << 8) | 15)

1.12 Palettised 12 Bit

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	0	0	0	0	13	0	4

#define **PMXDD_FORMAT_PAL12** ((13 << 8) | 4)

Note: Not supported on PMX-1C hardware.

1.13 Palettised 8 Bit

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	1	0	0	0	14	0	3

#define **PMXDD_FORMAT_PAL8** ((1 << 24) | (0 << 16) | (14 << 8) | 3)

Note: Not supported on PMX-1C hardware

1.14 Palettised 4 Bit

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	0	0	0	0	15	0	2

#define **PMXDD_FORMAT_PAL4** ((15 << 8) | 2)

Note: Not supported on PMX-1C hardware

1.15 Palettised 2 Bit

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	0	0	0	0	16	0	1

#define **PMXDD_FORMAT_PAL2** ((16 << 8) | 1)

Note: Not supported on PMX-1C hardware

1.16 Palettised 1 Bit

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	0	0	0	0	17	0	0

#define **PMXDD_FORMAT_PAL1** ((17 << 8) | 0)

Note: Not supported on PMX-1C hardware

1.17 ARGB 1555

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	3	18	0	3

#define **PMXDD_FORMAT_ARGB1555** ((2 << 24) | (3 << 16) | (18 << 8) | 3)

1.18 ARGB 4444

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	2	0	0	1	19	0	1

#define **PMXDD_FORMAT_ARGB4444** ((2 << 24) | (1 << 16) | (19 << 8) | 1)

1.19 ARGB 8888

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	4	0	0	0	20	0	0

#define **PMXDD_FORMAT_ARGB8888** ((4 << 24) | (0 << 16) | (20 << 8) | 0)

1.20 ABGR 8888

Res	Pixel Stride	Res	Zero Alpha	Pack Mode	Magic Number	Res	Unpack Mode
31-27	26-24	23-22	21	20-16	15-8	7-5	4-0
0	4	0	0	16	21	0	16

#define **PMXDD_FORMAT_ABGR8888** ((4 << 24) | (16 << 16) | (21 << 8) | 16)

2. Background Thread Command Header

Each command sent to the background thread using the CCB (Circular Command Buffer) requires a PMXCOM_HEADER structure defined at the start of the command's parameter structure to be filled in. This defines the physical address of the code fragment, which will execute the command requested (in relation to this document each blit type has a unique code fragment).

The address of each of the code fragments is returned (as a service table) from the Kernal Manager once the code fragments are loaded.

```
typedef struct _PMXCOM_HEADER_
{
        DWORD   dwSize;
        DWORD   dwServiceAddr;
} PMXCOM_HEADER;
```

dwSize

Size of the command structure in bytes.

dwServiceAddr

Physical address of the command code fragment.

3. Additional Blit Parameters

Most blits allow additional parameters to be passed within the **dwFlags** field. These can be a combination of the following. Note not all these flags can be specified on all the blit types. Check the blit specifications at the end of this document to see which of these flags available for any given blit.

PMX2D_USE_SRCCOLOURKEY

Enable source colour keying (the selected colour key should be placed in **dwColourKey**).

```
#define PMX2D_USE_SRCALPHACONST          (1 << 8)
```

PMX2D_USE_CLIPRGN

Enable clipping. **dwClipYminXmin** and **dwClipYmaxXmax** will be used as the clipping region.

```
#define PMX2D_USE_CLIPRGN                (1 << 2)
```

PMX2D_USE_REPLICATED_CHROMA

Enable replicated chroma during colour space conversion blits, otherwise interpolated chroma will be used. This flag is related to a FourCC pixel format conversion to an RGB pixel format.

```
#define PMX2D_USE_REPLICATED_CHROMA      (1 << 10)
```

PMX2D_USE_BILINEAR

Enable bilinear filtering. If this flag is not enabled, pixel replication will be used. The flag is related to blits which involve scaling.

#define PMX2D_USE_BILINEAR (1 << 9)

PMX2D_USE_DITHER

Enable dithering. When the source surface pixel format is 32 or 24 bit RGB and the destination surface pixel format is 16 or 15 bit RGB, enabling this flag will dither the pixels.

#define **PMX2D_USE_DITHER** (1 << 18)

4. General Blit Setup

All blits are designed so be as simple to setup and use as possible, some additional information on using the Blits are given here.

4.1 Blit Syncronisation

All blits contain parameters similar to the following, Colour Fill Blit being the exception as it only has a destination surface and not a source surface.

```
DWORD  dwSrcOpReqNum
DWORD  dwSrcLastOpDoneAddr
DWORD  dwDestOpReqNum
DWORD  dwDestLastOpDoneAddr
```

These can be used for synchronising the blits with other (asynchronous) operations. An example being a 3d render waiting for a blit to complete or the blit waiting for a flip to complete on its destination surface before the blit will start.

4.1.1 Blit Initialisation

Each blit before starting detects if any flips are outstanding. If so the **dwDestOpDoneAddr** location is polled until the value at this location becomes **dwDestOpReqNum**-1, this signifies all outstanding operations on the destination surface are complete before the current blit starts.

4.1.2 Blit Completion

Once the hardware has completed the transfer the **dwSrcOpReqNum** and **dwDestOpReqNum** will be sent to the physical locations defined by **dwSrcLastOpDoneAddr** and **dwDestLastOpDoneAddr** respectively. These can be used to indicate that the hardware has finished with both the source and destination surfaces and other operations waiting to occur on these surfaces can start.

5. BLIT TYPES

Listed are all the Blit types currently supported.

5.1 Colour Fill Blit

The Colour Fill Blit can be used to fill either a rectangle or an entire surface with a single colour. All RGB pixel formats are supported but it is also possible to support other pixel formats, such as FourCC formats by defining a comparable supported pixel format. An example being selecting ARGB8888 as the **dwDestFormat** and passing a YUYV colour in **dwColour** (as these both have the same bytes per pixel the blit will work).

```
typedef struct _COLOUR_FILL_
{
        PMXCOM_HEADER           sCommand;
        DWORD                   dwDestFormat;
        DWORD                   dwColour;
        DWORD                   dwDestAddr;
        DWORD                   dwDestLineStride;
        WORD                    wDestStartX;
        WORD                    wDestStartY;
        WORD                    wDestSizeY;
        WORD                    wDestSizeX;
        DWORD                   dwClipYminXmin;
        DWORD                   dwClipYmaxXmax;
        DWORD                   dwDestOpReqNum;
        DWORD                   dwDestLastOpDoneAddr;
        DWORD                   dwFlags;
} COLOUR_FILL, *PCOLOUR_FILL;
```

dwDestFormat

Pixel formats which can be used as the destination pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwColour

Colour used to fill the surface. This value must be in a pixel format approriate to the pixel format of the destination surface. For a palettised surface it should be a palette index.

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

dwDestLineStride

Width of surface (in pixels).

wDestStartX

Start X coordinate of the blit (in pixels).

WDestStartY

Start Y coordinate of the blit (in pixels).

wDestSizeY

Height of the blit (in pixels).

wDestSizeX

Width of the blit (in pixels).

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

dwFlags

None, **PMX2D_USE_CLIPRGN** currently assumed always to be enabled, if no clipping is required set **dwClipYminXmin** to 0 and **dwClipYmaxXmax** to 0xffffffff which in effect disables the clipping.

5.2 Same Format Blit

The Same Format Blit is designed for copying rectangles or complete surfaces where the source and destination surface both have the same pixel format. Source colour keying is also supported – but not for 24 bit modes. If source colourkeying is required

for a 24-bit surface then **Simple Format Blit** should be used. This exception will not be necessary on PMX-LC.

The blit also handles overlapping source and destination rectangles and will transfer the data right-to-left or bottom-up if an overlap is detected to avoid corrupting the source rectangle.

Simple Format Blit can also be used for this purpose but pixel format conversion will occur – even if both the source and destination pixel formats are the same. This results in **Simple Format Blit** having a reduced throughput and so **Same Format Blit** should always be used unless pixel format conversion is required.

```
typedef struct _SAME_FORMAT_BLT_
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwSrcAddr;
        DWORD               dwDestAddr;
        WORD                wSrcStartX;
        WORD                wSrcStartY;
        WORD                wDestStartY;
        WORD                wDestStartX;
        WORD                wSizeX;
        WORD                wSizeY;
        WORD                wSrcLineStride;
        WORD                wDestLineStride;
        DWORD               dwFlags;
        DWORD               dwColourKey;
        DWORD               dwClipYminXmin;
        DWORD               dwClipYmaxXmax;
        DWORD               dwSrcOpReqNum;
        DWORD               dwSrcLastOpDoneAddr;
        DWORD               dwDestOpReqNum;
        DWORD               dwDestLastOpDoneAddr;
        DWORD               dwFormat;
} SAME_FORMAT_BLT, *PSAME_FORMAT_BLT;
```

dwSrcAddr

Physical address of the source surface (the one that is being blitted from).

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

wSrcStartX

Start X coordinate of the source surface that is to be blitted from (in pixels).

wSrcStartY

Start Y coordinate of the source surface that is to be blitted from (in pixels).

wDestStartY

Start Y coordinate of the destination surface to be blitted to (in pixels).

wDestStartX

Start X coordinate of the destination surface to be blitted to (in pixels).

wSizeX

Width of the blit (in pixels).

wSizeY

Height of the blit (in pixels).

wSrcLineStride

Width of source surface (in pixels).

wDestLineStride

Width of destination surface (in pixels).

dwFlags

Flags that specify additional parameters for the blit.

- **PMX2D_USE_SRCCOLOURKEY**
- **PMX2D_USE_CLIPRGN**

dwColourKey

The colour used as the source colour key. This value must be in a pixel format approriate to the pixel format of the source surface. For a palettised surface it should be a palette index.

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwSrcOpReqNum

The blit operation number which will be written to **dwSrcLastOpDoneAddr** once the blit has completed.

dwSrcLastOpDoneAddr

Physical address of where the **dwSrcOpReqNum** value will be written to once the blit has completed.

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

dwFormat

Pixel formats which can be used.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE
- PMXDD_FORMAT_PAL8

5.3 Simple Format Blit

Simple Format Blit should be used for blitting between surfaces where the source and destination RGB pixel formats differ. Whilst blitting between the two a pixel format conversion occurs.

Note: only RGB pixel formats are supported here, for FourCC to RGB pixel format conversions the Colour Space Conversion Blit must be used.

The blit also handles overlapping source and destination rectangles and will transfer the data right-to-left, or bottom-up if overlap is detected to avoid corrupting the source rectangle.

```
typedef struct _SIMPLE_BLT_
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwSrcAddr;
        DWORD               dwDestAddr;
        WORD                wSrcStartX;
        WORD                wSrcStartY;
        WORD                wDestStartY;
        WORD                wDestStartX;
        WORD                wSizeX;
        WORD                wSizeY;
        WORD                wSrcLineStride;
        WORD                wDestLineStride;
        DWORD               dwSrcFormat;
        DWORD               dwDestFormat;
        DWORD               dwClipYminXmin;
```

```
    DWORD       dwClipYmaxXmax;
    DWORD       dwPaletteBase;
    DWORD       dwFlags;
    DWORD       dwSrcOpReqNum;
    DWORD       dwSrcLastOpDoneAddr;
    DWORD       dwDestOpReqNum;
    DWORD       dwDestLastOpDoneAddr;
    DWORD       dwColourKey;
} SIMPLE_BLT, *PSIMPLE_BLT;
```

dwSrcAddr

Physical address of the source surface (the one that is being blitted from).

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

wSrcStartX

Start X coordinate of the source surface that is to be blitted from (in pixels).

wSrcStartY

Start Y coordinate of the source surface that is to be blitted from (in pixels).

wDestStartY

Start Y coordinate of the destination surface to be blitted to (in pixels).

wDestStartX

Start X coordinate of the destination surface to be blitted to (in pixels).

wSizeX

Width of the blit (in pixels).

wSizeY

Height of the blit (in pixels).

wSrcLineStride

Width of source surface (in pixels).

wDestLineStride

Width of destination surface (in pixels).

dwSrcFormat

Pixel formats which can be used as the source pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwDestFormat

Pixel formats which can be used as the destination pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwPaletteBase

Currently unused.

dwFlags

Flags that specify additional parameters for the blit.

- **PMX2D_USE_SRCCOLOURKEY**
- **PMX2D_USE_CLIPRGN**
- **PMX2D_USE_DITHER**

dwSrcOpReqNum

The blit operation number which will be written to **dwSrcLastOpDoneAddr** once the blit has completed.

dwSrcLastOpDoneAddr

Physical address of where the **dwSrcOpReqNum** value will be written to once the blit has completed.

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

dwColourKey

The colour used as the source colour key. This value must be in a pixel format approriate to the pixel format of the source surface. For a palettised surface it should be a palette index.

5.4 Scaled Blit

The Scaled Blit should be used for blitting rectangles or complete surfaces were the source and destination rectanges are of different arbitary sizes. The blit handles surfaces where the source and destination RGB pixel formats differ. Also a source colour key can be used – but with the restriction that bilinear filtering be disabled.

```
typedef struct _SCALED_BLT_
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwSrcAddr;
        DWORD               dwDestAddr;
        WORD                wSrcStartX;
        WORD                wSrcStartY;
        WORD                wDestStartY;
        WORD                wDestStartX;
        WORD                wDestSizeX;
        WORD                wDestSizeY;
        WORD                wSrcLineStride;
        WORD                wDestLineStride;
        DWORD               dwSrcIncX;
        DWORD               dwSrcIncY;
        DWORD               dwSrcFormat;
        DWORD               dwDestFormat;
        DWORD               dwClipYminXmin;
        DWORD               dwClipYmaxXmax;
        DWORD               dwPaletteBase;
        DWORD               dwFlags;
        DWORD               dwSrcOpReqNum;
        DWORD               dwSrcLastOpDoneAddr;
        DWORD               dwDestOpReqNum;
        DWORD               dwDestLastOpDoneAddr;
        DWORD               dwColourKey;
} SCALED_BLT, *PSCALED_BLT;
```

dwSrcAddr

Physical address of the source surface (the one that is being blitted from).

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

wSrcStartX

Start X coordinate of the source surface that is to be blitted from (in pixels).

wSrcStartY

Start Y coordinate of the source surface that is to be blitted from (in pixels).

wDestStartY

Start Y coordinate of the destination surface to be blitted to (in pixels).

wDestStartX

Start X coordinate of the destination surface to be blitted to (in pixels).

wDestSizeX

Width of the blit (in pixels).

wDestSizeY

Height of the blit (in pixels).

wSrcLineStride

Width of source surface (in pixels).

wDestLineStride

Width of destination surface (in pixels).

dwSrcIncX

Scaling factor on the X axis. The low word containing integer multiplication factors and the high word containing integer division factors.

31 - 20	19	18	17	16	15	14	13	12	11-0
...	1/8	1/4	1/2	1/1	X2	X4	X8	X16	...

These can be calculated using the calculation defined below. Bilinear and Non-Bilinear filtered blits require different calculations to determine the scaling factors. This is due to the bilinear filtered blit reading two source pixels and interpolating for each destination pixel. A problem can occure where the source edge pixels get interpolated with pixels outside of the defined rectangle resulting in an underfined interpolation.

Using the Bilinear calculation ensures this will not happen.

Non-Bilinear

```
dwSrcIncX =   dwSourceWidth << 16 /  dwDestinationWidth;
dwSrcIncY =   dwSourceHeight << 16 / dwDestinationHeight;
```

Bilinear

```
dwSrcIncY = ((dwSourceWidth-1) << 16) / (dwDestinationWidth-1);
dwSrcTemp = (dwSrcIncX * (dwDestinationWidth-1)) >> 16;
```

```
if(dwSrcTemp >= (dwSourceWidth-1))
{
        dwSrcIncX-=1;
}

dwSrcIncY = ((dwSourceHeight-1) << 16) / (dwDestinationHeight-1);
dwSrcTemp = (dwSrcIncY * (dwDestionationHeight-1)) >> 16;
if(dwSrcTemp >= (dwSourceHeight-1))
{
        dwSrcIncY-=1;
}
```

dwSrcIncY

Scaling factor on the Y axis. The low word containing integer multiplication factors and the high word containing integer division factors.

31 - 20	19	18	17	16	15	14	13	12	11-0
...	1/8	1/4	1/2	1/1	X2	X4	X8	X16	...

dwSrcFormat

Pixel formats which can be used as the source pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwDestFormat

Pixel formats which can be used as the destination pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwPaletteBase

Currently unused.

dwFlags

Flags that specify additional parameters for the blit.

- **PMX2D_USE_SRCCOLOURKEY**
- **PMX2D_USE_CLIPRGN**
- **PMX2D_USE_BILINEAR**
- **PMX2D_USE_DITHER**

dwSrcOpReqNum

The blit operation number which will be written to **dwSrcLastOpDoneAddr** once the blit has completed.

dwSrcLastOpDoneAddr

Physical address of where the **dwSrcOpReqNum** value will be written to once the blit has completed.

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

dwColourKey

The colour used as the source colour key. This value must be in a pixel format approriate to the pixel format of the source surface. For a palettised surface it should be a palette index.

5.5 Colour Space Conversion Blit

Colour Space Conversion Blits should be used for blitting between surfaces where the source pixel format is a supported FourCC format and the destination pixel format is an RGB format. Chroma interpolation will automatically be used unless the **PMX2D_USE_REPLICATED_CHROMA** flag is selected. When interpolating chroma the blit handles rectangles where the width is an even number of pixels correctly, by replicated the chroma on the rightmost edge pixel. The problem being that each even pixel is an interpolation of its current macropixel UV and the following macropixel UV:

Chroma Interpolation

0	1	2	3
Y_0	U_0	Y_1	V_0

4	5	6	7
Y_2	U_1	Y_3	V_1

Pixel 1 = $Y_0U_0V_0$

Pixel 2 = $Y_1\frac{(U_0+U_1)}{2}\frac{(V_0+V_1)}{2}$

Pixel 3 = $Y_2U_1V_1$

Pixel 4 = Y_3....

This results in the final pixel using an interpolation of it's own UV and an unknown UV from the following macropixel. Using replicated chroma if the final pixel is an even pixel solves this uncertainty. The blit detects this and handles it automatically.

```
typedef struct _CCONV_BLT_
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwClipYminXmin;
        DWORD               dwClipYmaxXmax;
        DWORD               dwSrcFormat;
        DWORD               dwDestFormat;
        DWORD               dwMaccCf0;
        DWORD               dwMaccCf1;
        DWORD               dwSrcAddr;
        DWORD               dwDestAddr;
        WORD                wSrcStartX;
        WORD                wSrcStartY;
        WORD                wDestStartY;
        WORD                wDestStartX;
        WORD                wSizeX;
        WORD                wSizeY;
        WORD                wSrcLineStride;
        WORD                wDestLineStride;
        DWORD               dwPaletteBase;
```

```
    DWORD           dwFlags;
    DWORD           dwSrcOpReqNum;
    DWORD           dwSrcLastOpDoneAddr;
    DWORD           dwDestOpReqNum;
    DWORD           dwDestLastOpDoneAddr;
} CCONV_BLT, *PCCONV_BLT;
```

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwSrcFormat

Pixel formats which can be used as the source pixel format.

- PMXDD_FORMAT_YUV444
- PMXDD_FORMAT_VUY444
- PMXDD_FORMAT_YUYV
- PMXDD_FORMAT_YVYU
- PMXDD_FORMAT_UYVY

dwDestFormat

Pixel formats which can be used as the destination pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwMaccCf0

Multiply Accumulate engine coefficient lookup table one.

31-30	29-25	24-20	19-15	14-10	9-5	4-0
Res	Macc_cf5	Macc_cf4	Macc_cf3	Macc_cf2	Macc_cf1	Macc_cf0

dwMaccCf1

Multiply Accumulate engine coefficient lookup table two.

31-25	24-20	19-15	14-10	9-5	4-0
Res	Macc_ofs1	Macc_ofs0	Macc_cf8	Macc_cf7	Macc_cf6

The **dwMaccCf0** and **dwMaccCf1** fields are used in defining a colour space conversion coefficient table required for processing FourCC pixel formats to RGB:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} Macc\_cf0 & Macc\_cf1 & Macc\_cf2 \\ Macc\_cf3 & Macc\_cf4 & Macc\_cf5 \\ Macc\_cf6 & Macc\_cf7 & Macc\_cf8 \end{bmatrix} \begin{bmatrix} Macc\_ofs0 \\ Macc\_ofs1 \\ Macc\_ofs1 \end{bmatrix}$$

As an example usage for this table the ITU-R recommendation 709 no.4 defines the following coefficient table for colour space conversion:

$$\begin{bmatrix} 1.0 & 1.366 & -0.002 \\ 1.0 & -0.7 & -0.334 \\ 1.0 & -0.006 & 1.732 \end{bmatrix} \begin{bmatrix} 0 \\ 128 \\ 128 \end{bmatrix}$$

The floating-point numbers are encoded into 5-bit values; the following encoding is used for the **Macc_cf0** – **Macc_cf8** fields. This only gives an approximation of each floating point value but gives a close enough result for the colour space conversion approximation to be unnoticeable.

4	3	2	1	0
-2	1	½	1/4	1/8

The **Macc_ofs0** and **Macc_ofs1** fields are encoded differently. These 5 bit values automatically get concatenated onto three zero bits. E.g. xxxxx::000. Encoding '128' therefore is a simple task of **Macc_ofs1** = 128 >> 3.

Encoding the recommendation gives a close approximation comparable to the above original table:

$$\begin{bmatrix} 01000b & 01011b & 00000b \end{bmatrix} \begin{bmatrix} 00000b \end{bmatrix} \begin{bmatrix} 1.0 & 1.375 & 0.0 \end{bmatrix} \begin{bmatrix} 0 \end{bmatrix}$$

01000b	**11010b**	**11101b**	**10000b**	**=**	**1.0**	**-0.75**	**-0.375**	**128**
01000b	**00000b**	**01110b**	**10000b**		**1.0**	**0.0**	**1.75**	**128**

dwSrcAddr

Physical address of the source surface (the one that is being blitted from).

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

wSrcStartX

Start X coordinate of the source surface that is to be blitted from (in pixels).

wSrcStartY

Start Y coordinate of the source surface that is to be blitted from (in pixels).

wDestStartY

Start Y coordinate of the destination surface to be blitted to (in pixels).

wDestStartX

Start X coordinate of the destination surface to be blitted to (in pixels).

wSizeX

Width of the blit (in pixels).

wSizeY

Height of the blit (in pixels).

wSrcLineStride

Width of source surface (in pixels).

wDestLineStride

Width of destination surface (in pixels).

dwPaletteBase

Currently unused.

dwFlags

Flags that specify additional parameters for the blit.

- **PMX2D_USE_CLIPRGN**
- **PMX2D_USE_REPLICATED_CHROMA**

dwSrcOpReqNum

The blit operation number which will be written to **dwSrcLastOpDoneAddr** once the blit has completed.

dwSrcLastOpDoneAddr

Physical address of where the **dwSrcOpReqNum** value will be written to once the blit has completed.

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

5.6 Scaled Colour Space Conversion Blit

Scaled Colour Space Conversion Blit should be used where the source and destination surfaces have differing rectangle sizes, also the source pixel format is a supported FourCC format and the destination pixel format is an RGB format. Bilinear filtering should not be used in conjunction with interpolated chroma as no rightedge pixel chroma replication (as discussed in Colour Space Conversion Blit) is detected and handled. Although the effect of using the two together will cause only minor, if any, noticeable artefacts at the most.

```
typedef struct _SCALED_CCONV_BLT_
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwClipYminXmin;
        DWORD               dwClipYmaxXmax;
        DWORD               dwSrcFormat;
        DWORD               dwDestFormat;
        DWORD               dwMaccCf0;
        DWORD               dwMaccCf1;
        DWORD               dwSrcAddr;
        DWORD               dwDestAddr;
        WORD                wSrcStartX;
        WORD                wSrcStartY;
        WORD                wDestStartY;
        WORD                wDestStartX;
        WORD                wSrcLineStride;
        WORD                wDestLineStride;
        WORD                wDestSizeX;
        WORD                wDestSizeY;
        DWORD               dwSrcIncX;
        DWORD               dwSrcIncY;
        DWORD               dwPaletteBase;
        DWORD               dwFlags;
        DWORD               dwSrcOpReqNum;
        DWORD               dwSrcLastOpDoneAddr;
        DWORD               dwDestOpReqNum;
        DWORD               dwDestLastOpDoneAddr;
} SCALED_CCONV_BLT, *PSCALED_CCONV_BLT;
```

dwClipYminXmin

The top-left X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymin	Res	Xmin

dwClipYmaxXmax

The bottom-right X, Y coordinates of the clipping region (in pixels), this field is only valid if **PMX2D_USE_CLIPRGN** is defined in **dwFlags**. Bits 0-13 define the X coord and bits 16-27 define the Y coord, all other bits are unused.

31-28	27-16	15-14	13-0
Res	Ymax	Res	Xmax

dwSrcFormat

Pixel formats which can be used as the source pixel format.

- PMXDD_FORMAT_YUV444
- PMXDD_FORMAT_VUY444
- PMXDD_FORMAT_YUYV
- PMXDD_FORMAT_YVYU
- PMXDD_FORMAT_UYVY

dwDestFormat

Pixel formats which can be used as the destination pixel format.

- PMXDD_FORMAT_RGB565
- PMXDD_FORMAT_RGB555
- PMXDD_FORMAT_RGB888
- PMXDD_FORMAT_BGR888
- PMXDD_FORMAT_ARGB1555
- PMXDD_FORMAT_ARGB4444
- PMXDD_FORMAT_ARGB8888
- PMXDD_FORMAT_ABGR8888
- PMXDD_FORMAT_GREY_SCALE

dwMaccCf0

Multiply Accumulate engine coefficient lookup table one. (see Colour Space Conversion for a detailed description).

dwMaccCf1

Multiply Accumulate engine coefficient lookup table two. (see Colour Space Conversion for a detailed description).

dwSrcAddr

Physical address of the source surface (the one that is being blitted from).

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

wSrcStartX

Start X coordinate of the source surface that is to be blitted from (in pixels).

wSrcStartY

Start Y coordinate of the source surface that is to be blitted from (in pixels).

wDestStartY

Start Y coordinate of the destination surface to be blitted to (in pixels).

wDestStartX

Start X coordinate of the destination surface to be blitted to (in pixels).

wSrcLineStride

Width of source surface (in pixels).

wDestLineStride

Width of destination surface (in pixels).

wDestSizeX

Width of the blit (in pixels).

wDestSizeY

Height of the blit (in pixels).

dwSrcIncX

Scaling factor on the X axis. The low word containing integer multiplication factors and the high word containing integer division factors. See Scaled Blit for further information.

31 - 20	19	18	17	16	15	14	13	12	11-0
...	1/8	1/4	1/2	1/1	X2	X4	X8	X16	...

dwSrcIncY

Scaling factor on the Y axis. The low word containing integer multiplication factors and the high word containing integer division factors. See Scaled Blit for further information.

31 - 20	19	18	17	16	15	14	13	12	11-0
...	1/8	1/4	1/2	1/1	X2	X4	X8	X16	...

dwPaletteBase

Currently unused.

dwFlags

Flags that specify additional parameters for the blit.

- **PMX2D_USE_CLIPRGN**
- **PMX2D_USE_BILINEAR**
- **PMX2D_USE_REPLICATED_CHROMA**

dwSrcOpReqNum

The blit operation number which will be written to **dwSrcLastOpDoneAddr** once the blit has completed.

dwSrcLastOpDoneAddr

Physical address of where the **dwSrcOpReqNum** value will be written to once the blit has completed.

dwDestOpReqNum

The blit operation number which will be written to **dwDestLastOpDoneAddr** once the blit has completed.

dwDestLastOpDoneAddr

Physical address of where the **dwDestOpReqNum** value will be written to once the blit has completed.

5.7 Deplanarise Blit

The Deplanarise Blit can be used for pixel format conversions of YUV420 surfaces to VYUY or UYVY surfaces. This is useful for motion compensation where source surfaces are in planar mode, but the DAC does not support planar. Using the Deplanarise Blit can be used to convert the surface into a mode the DAC does support.

```
typedef struct _DEPLANARISE420_BLT
{
        PMXCOM_HEADER       sCommand;
        DWORD               dwSrcYAddr;
        DWORD               dwSrcUAddr;
        DWORD               dwSrcVAddr;
        DWORD               dwDestAddr;
        DWORD               dwSizeX;
        DWORD               dwSizeY;
        DWORD               dwDestStride;
        DWORD               dwOpReqNum;
} DEPLANARISE420_BLT, *PDEPLANARISE420_BLT;
```

dwSrcYAddr

Physical address of the source Y plane surface.

dwSrcUAddr

Physical address of the source U plane surface.

dwSrcVAddr

Physical address of the source V plane surface.

dwDestAddr

Physical address of the destination surface (the one that is being blitted to).

dwSizeX

Width of the blit / Y plane (in pixels / bytes as one Y per pixel).

dwSizeY

Height of the blit / Y plane (in pixels / bytes).

dwDestStride

Width of destination surface (in pixels).

dwOpReqNum

The blit operation number which will be written to **dwLastOpDone** once the blit has completed.